

Missile (SAM) battery. For example, three or more aircraft may time the arrival of electromagnetic energy emanating from the SAM battery. By measuring signal arrival time from the battery to the three or more aircraft, the location of the battery is determined. Clocks on the aircraft are synchronized via Global Positioning System (GPS) satellite clocks to enhance distance computation accuracy. Subsequently, a missile equipped with GPS/inertial guidance system is guided toward the measured position, i.e., GPS coordinates of the SAM battery.

[0041] The location of the missile during flight is measured by the on-board GPS/inertial guidance system to facilitate missile guidance. However, GPS guidance systems are susceptible to jamming, such as via jamming transmitters located near the target. In addition, GPS/inertial guidance systems often employ an expensive five element null-steering antenna. The null-steering antenna is capable of steering nulls to four jamming units. Consequently, use of more than four jamming units can successfully jam the accompanying GPS/inertial guidance system by overcoming the weak GPS signals from satellites.

[0042] Prior Art search and rescue operations for coastal applications have only recently implemented advanced technology to provide quick and accurate tracking capabilities for locating vessels in distress. In the Prior Art, a vessel in distress would attempt to contact the local Coast Guard on VHF channel 16, report their position, and wait for rescue. Unfortunately, since many mariners do not accurately know their position, such self-reporting often results in inaccurate data being transmitted, and as a result, delays in rescue attempts. In addition, false alarms by prank SOS announcements can waste valuable Coast Guard resources. Moreover, since channel 16 in many areas (e.g., Ft. Lauderdale) is rather busy, oftentimes Coast Guard personnel cannot hear broadcasts from vessels in distress, as the signals may be “stepped on” by local recreational boaters.

[0043] Traditional triangulation techniques may be utilized to locate mariners in distress, by measuring radio signal direction from at least two on-shore locations, and then triangulating an off-shore position. However, such a technique requires that the radio signal be on long enough for the on-shore receivers to fix on the signal, and moreover that the signal is not interrupted by other radio traffic. Weak or intermittent signals, which often occur when a vessel is in distress (e.g., low or no battery power, engine room awash, or the like), or when the person in distress is using a hand-held portable radio, may be difficult to track.

[0044] To correct some of these problems, the U.S. Coast Guard offers MF/HF radiotelephone service to mariners as part of the Global Marine Distress and Safety System. This service, called digital selective calling (DSC), allows mariners to instantly send an automatically formatted a distress alert to the Coast Guard or other rescue authority anywhere in the world. Digital selective calling also allows mariners to initiate or receive distress, urgency, safety and routine radiotelephone calls to or from any similarly equipped vessel or shore station, without requiring either party to be near a radio loudspeaker. All new VHF and HF radiotelephones have DSC capability.

[0045] On Feb. 1, 1999, the Safety of Life at Sea (SOLAS) Convention, a treaty document, required all passenger ships and most other ships 300 grt and larger on international voyages, including all cargo ships, to carry DSC-equipped radios. Ships were allowed to turn off their 2182 kHz radio listening

watch on that date. The International Maritime Organization has postponed indefinitely plans to suspend this VHF watch on ships. It had originally planned to suspend this watch on Feb. 1, 2005.

[0046] Because of the safety problems that lack of communications interoperability would cause between SOLAS-regulated vessels (mostly cargo ships) and other vessels (recreational boaters, commercial fishing vessels, etc.), the Coast Guard petitioned the Federal Communications Commission in 1992 to require all marine radios made or sold in the U.S. to have a DSC capability. The Coast Guard had also asked the Radio Technical Commission for Maritime Services (RTCM), a non-profit professional organization, to develop a standard, which would allow incorporation of DSC in a marine radio without affecting the low-end market price of that radio for recreational boaters. The FCC solicited comments on that petition in 1992 and 1993, and prepared a Notice of Proposed Rulemaking on that and other maritime radiocommunications matters in early 1994. The FCC requested comments concerning that rulemaking from May to November 1995. On 27 Jun. 1997, the FCC adopted a Report and Order requiring radios type accepted on or after 17 Jun. 1999 to include this minimum DSC capability.

[0047] The International Telecommunications Union Sector for Radiocommunications has indicated that excessive test calls on MF/HF DSC distress and safety frequencies are overloading the system to the point where interference to distress and safety calls has become a cause for concern. To minimize possible interference, live testing on DSC distress and safety frequencies with coast stations should be limited to once a week as recommended by the International Marine Organization.

[0048] To date, only a limited number of DSC receivers have been installed by the Coast Guard. Many USCG Group offices operate MF DSC on a trial basis. The Coast Guard plans to declare a Sea Area A2 (have an operational MF DSC service) for the Contiguous US coast and Hawaii. The US currently does not have a declared Sea Area A2.

[0049] All DSC-equipped radios, and most GPS receivers, have an NMEA 0183 two-wire data interface connector. That NMEA interface allows any model of GPS to be successfully interconnected to any model of radio, regardless of manufacture. Although NMEA has no standard for the type of connector used, many if not most DSC and GPS receiver manufactures use bare wire connections. These wires are simply connected between the radio and the GPS by twisting the wires (preferably solder) and tape (preferably waterproof heat shrink tubing).

[0050] In operation, the boater presses a button (usually mounted on the back of the microphone, underneath a safety cover) to declare a distress condition. The DSC-equipped VHF radio then transmits the GPS-based location of the vessel digitally to a DSC-equipped receiver station, and rescue personnel can be dispatched to the distress site.

[0051] Thus, the DSC system suffers from a number of systemic and implementation problems. Many boaters have older radios without DSC capability, and it will be several years, if not decades, before all of these older-style radios are purged from the marketplace, as many recreational boaters do not see implementing DSC as a priority, and for many boaters, the cost of installing a new DSC radio is deemed excessive. In addition, many older GPS systems do not have the two-wire interface needed to connect to a DSC-compatible radio. Further, many boaters have not taken the time to make such